Groundwater Management Challenges in the High Plains Aquifer

For: Water Funding Task Force 2013

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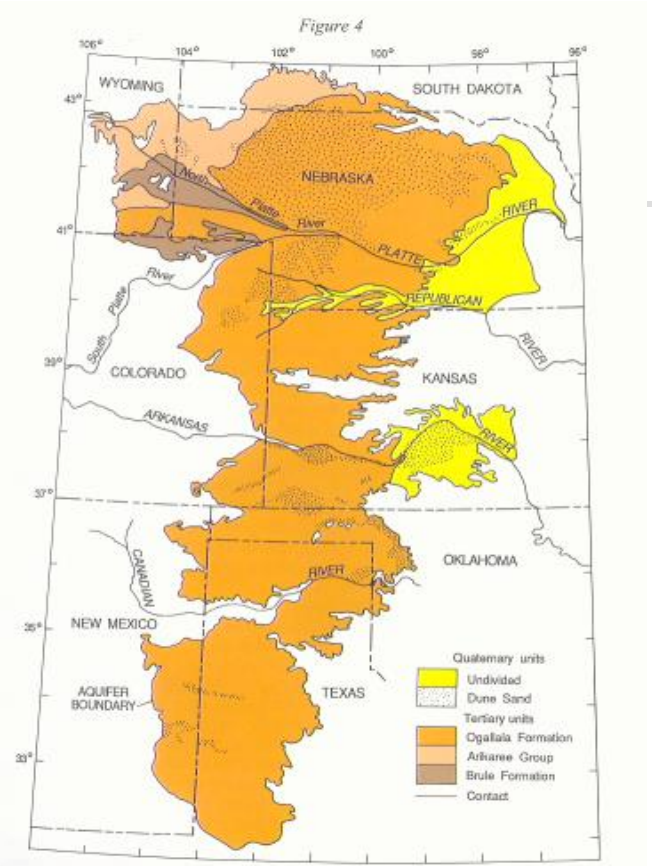


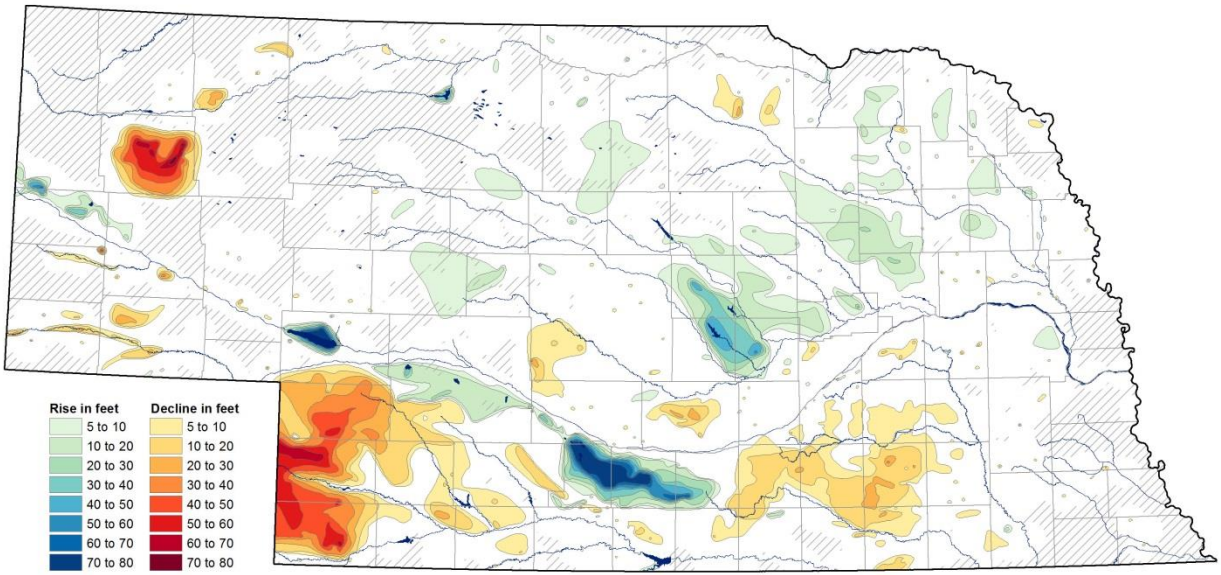
Geologic Units in the High Plains Aquifer

USGS

Management Challenges

- Basically Two Types
- 1 Ground Water vs Surface Water
- 2 Groundwater Depletion

Groundwater-level Changes in Nebraska - Predevelopment to Spring 2012



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U.S. Geological Survey
Nebraska Water Science Center

U.S. Bureau of Reclamation
Kansas-Nebraska Area Office

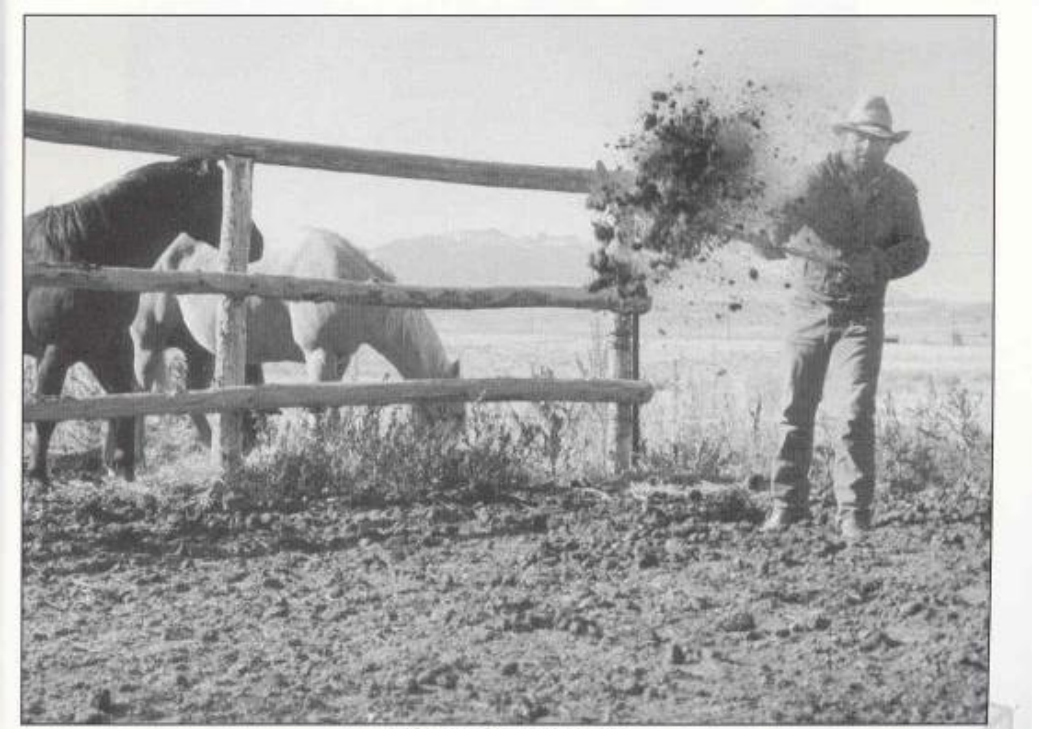
Nebraska Natural Resources Districts

Central Nebraska Public Power and Irrigation District

School of Natural Resources
Institute of Agriculture and Natural Resources
University of Nebraska–Lincoln

December 2012

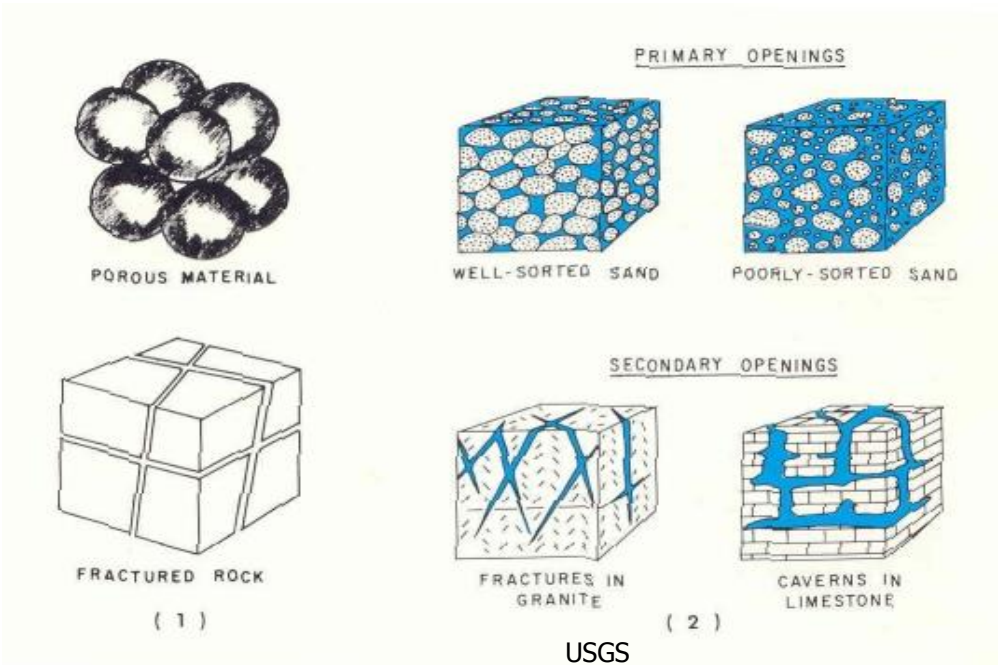
Water Issues Can Be Very Political



TRAINING FOR POLITICS

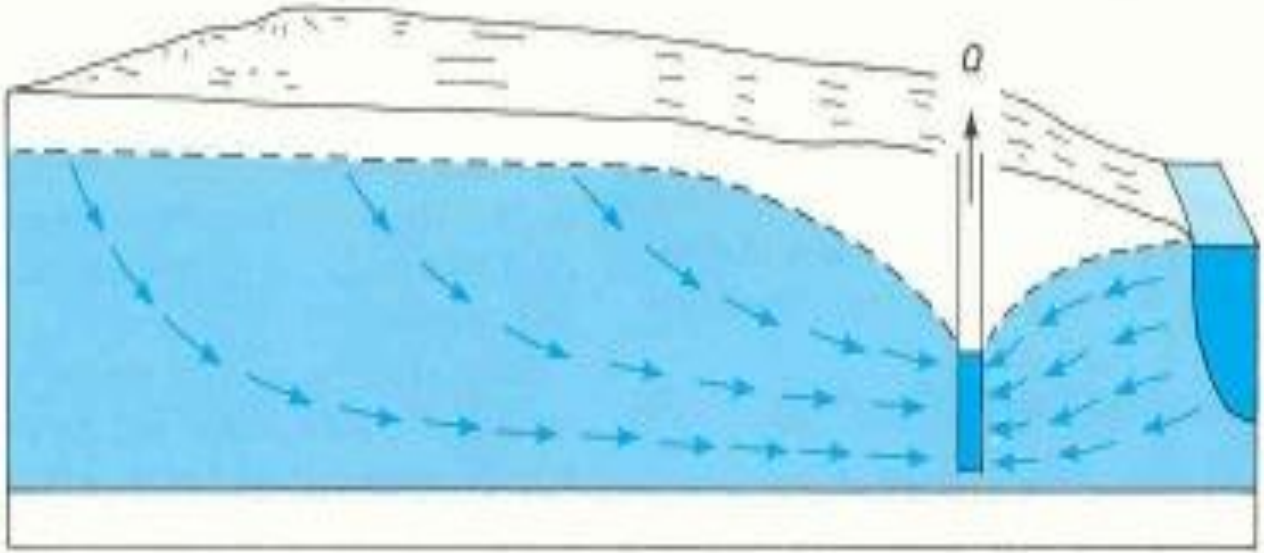
Photo by Paul Stanton, copyright 1991.

Modeling the Impact of Pumping Requires Understanding How Water Moves Through Porous Material



USGS

Stream Depletion Depends on Distance and Geology

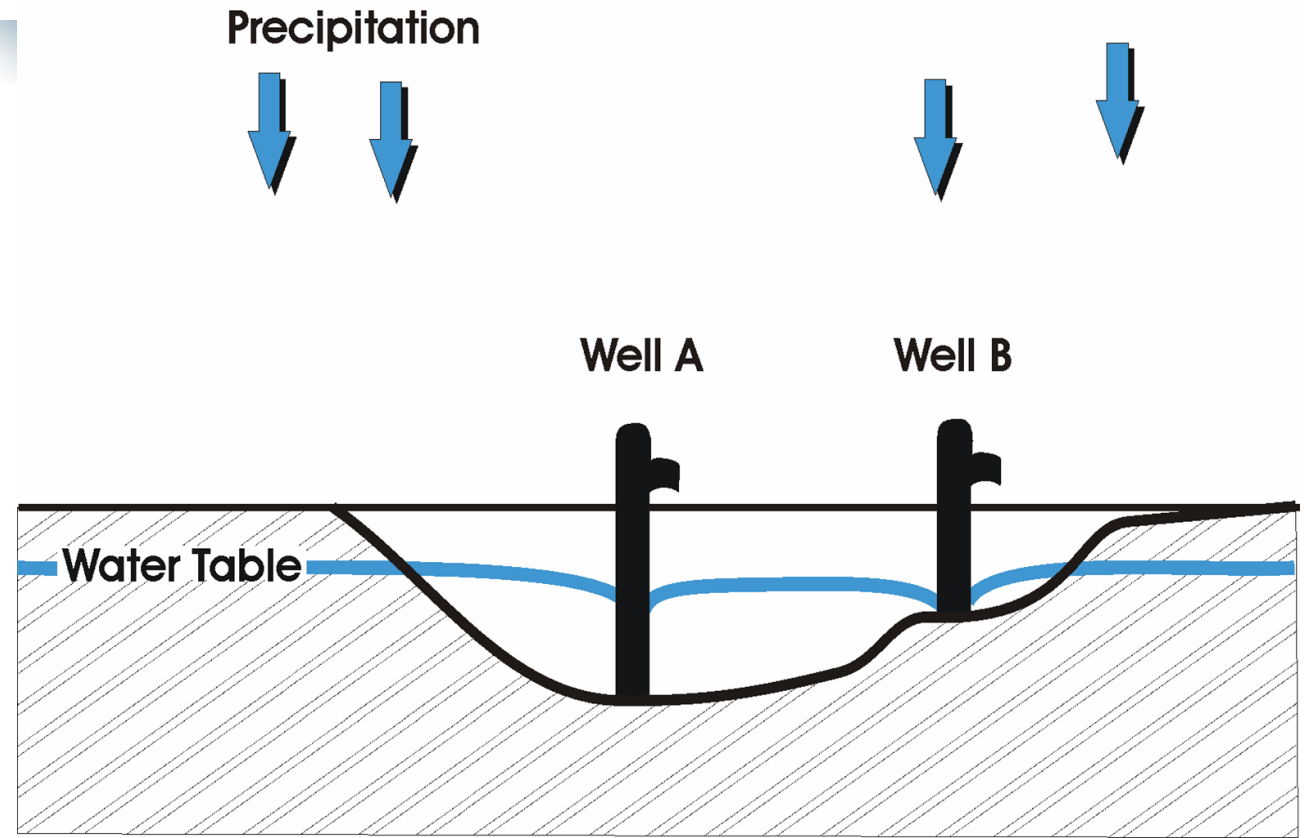


Withdrawal (Q) = Reduction in discharge ($\triangle D$) + Increase in recharge ($\triangle R$)

(4)

USGS

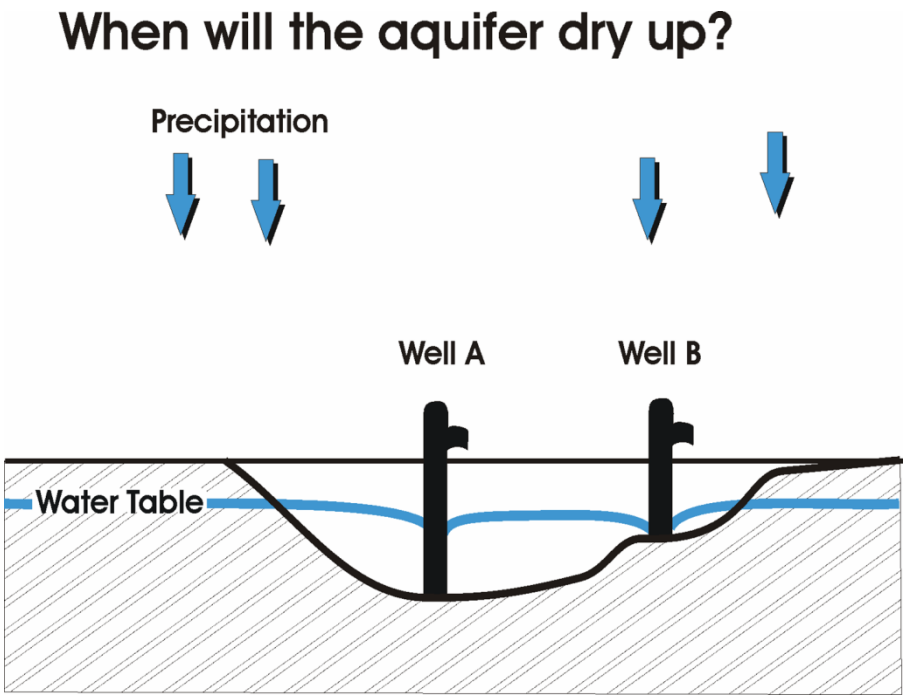
When will the aquifer dry up?



Why Can't We Pump The Aquifer Dry?

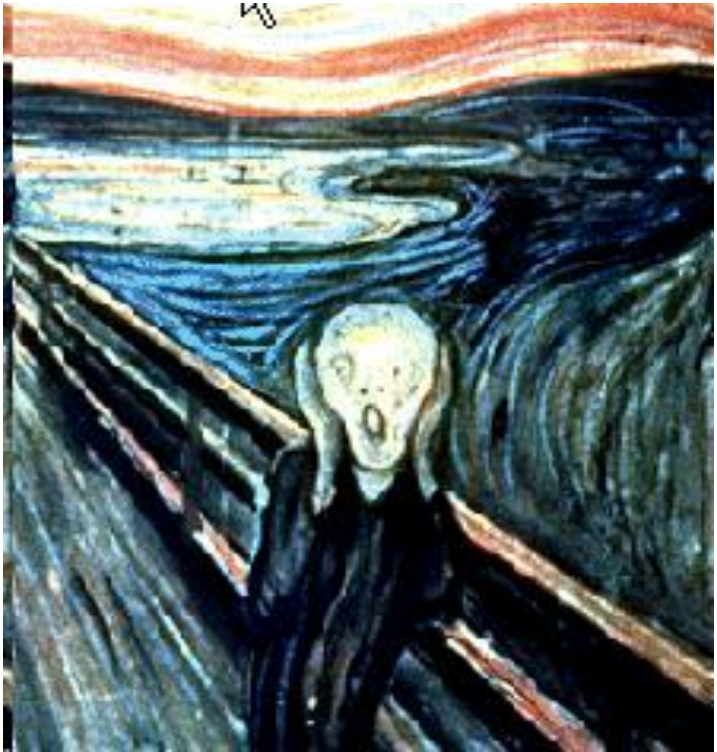
- Economic Limits
- Recharge & Renewable
- "Sweet Spots"
- "Survival of the Deepest" [Best Well, Best Soil, Other Factors]
- Depletion - Negative vs Positive Impacts

Overdevelopment or Over Pumping?



The Tragedy of the Commons

What Is The Sustainable Pumping Rate ?

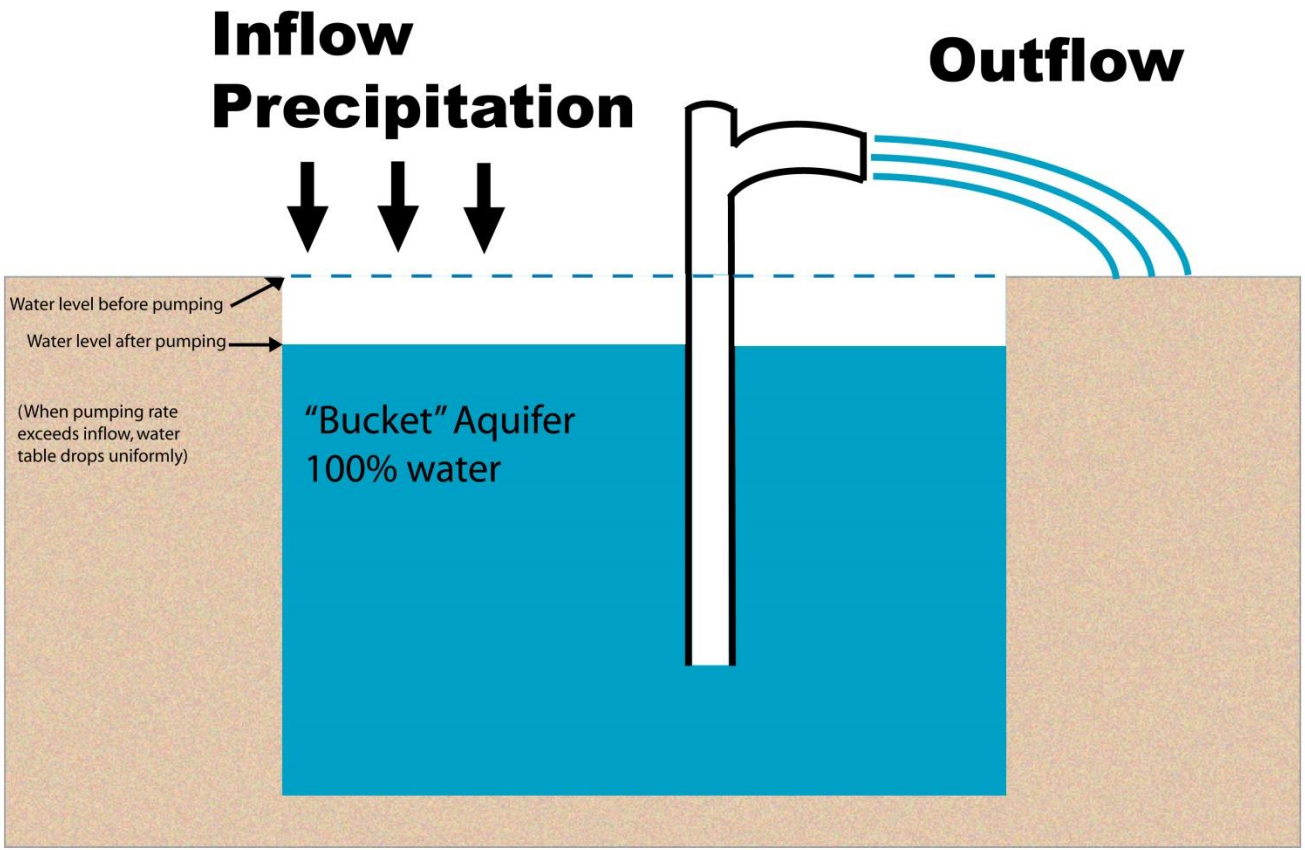


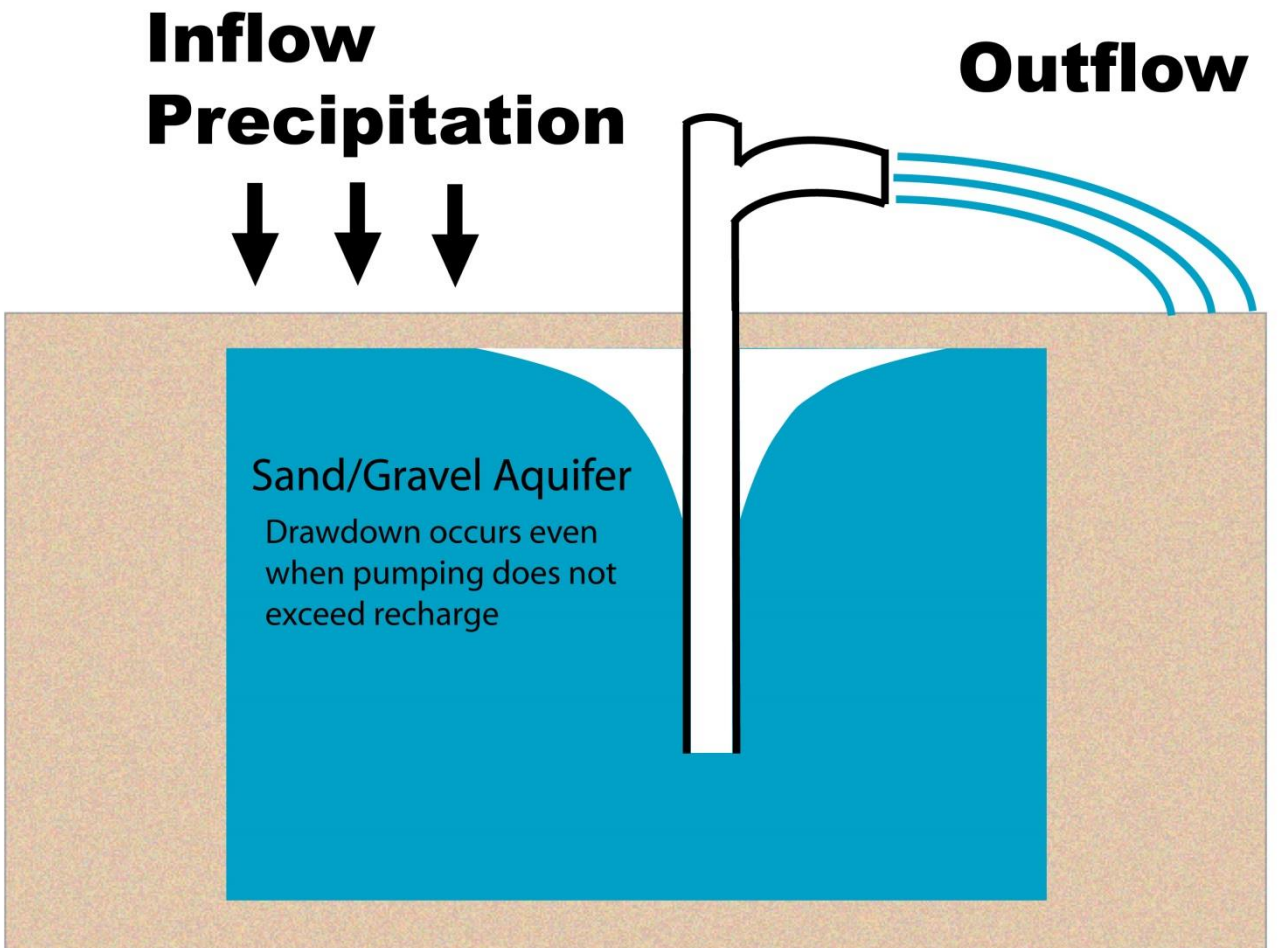
Is "Safe Yield" A Solution?

FOR EVERY COMPLEX PROBLEM, THERE IS A SOLUTION THAT IS SIMPLE, NEAT, AND **WRONG.** H. L. Mencken

"Safe Yield" is that Solution

Balancing Pumping with Recharge

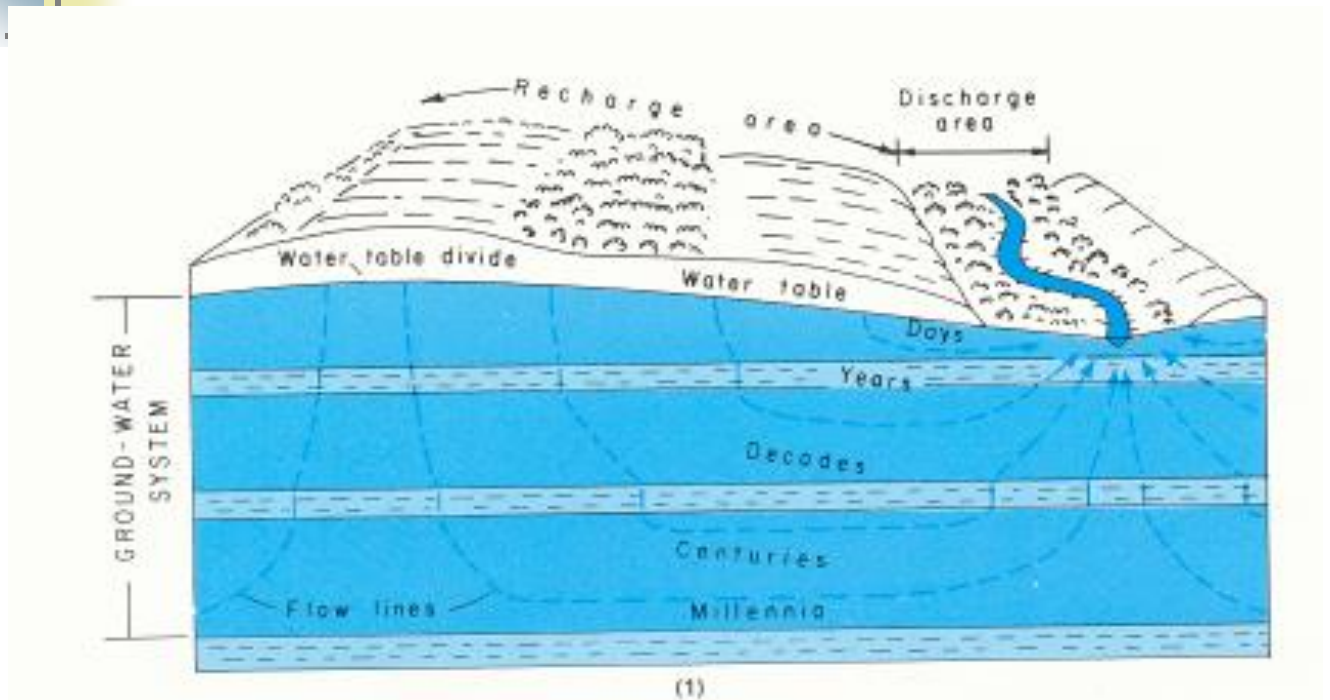

Inflow
Precipitation
Outflow
Water level before pumping
Water level after pumping
(When pumping rate exceeds inflow, water table drops uniformly)
"Bucket" Aquifer
100% water


Inflow
Precipitation
Outflow
Sand/Gravel Aquifer
Drawdown occurs even when pumping does not exceed recharge

Why Doesn't Balancing Recharge & Pumping Work?

- Geology "Localizes" Impacts
- Ground Water Moves Slowly
- There Are Always Impacts - GW Pumping
- Equilibrium = Steady State = Sustainable

Recharge and Discharge



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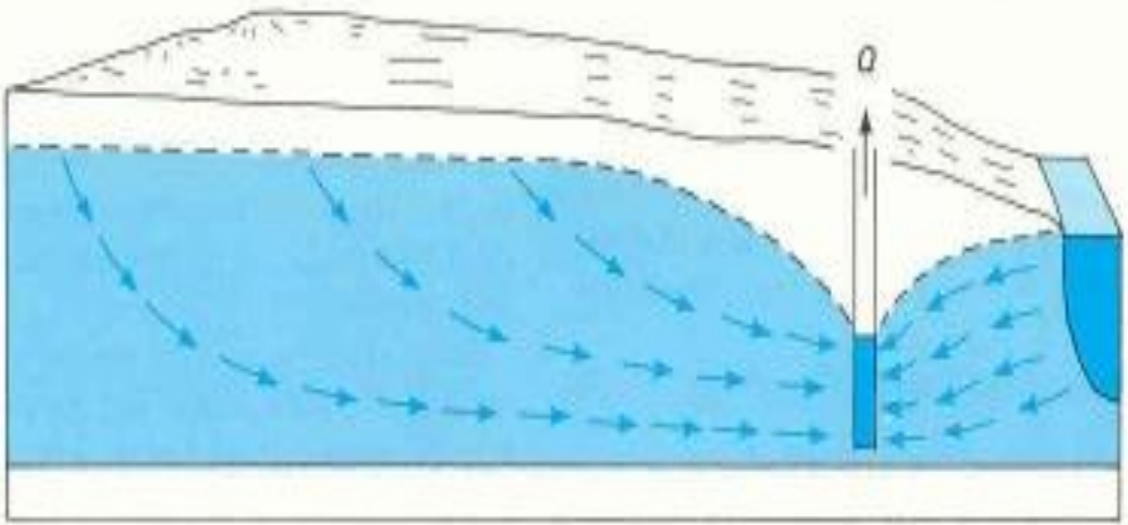
Source of Water for Wells

$$Qp = \Delta S + \Delta D + \Delta R$$

"Quantity of water pumped equals change in storage plus change in discharge plus change in recharge"

Induced Recharge



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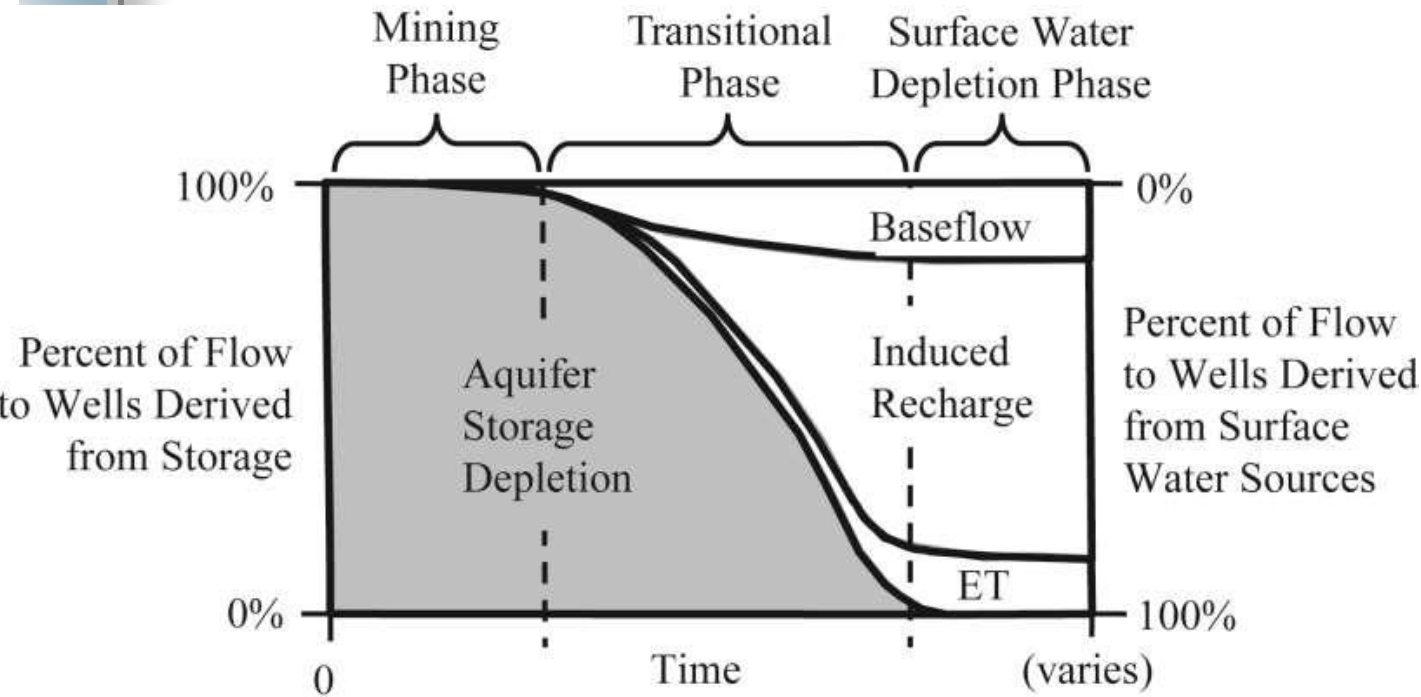
USGS



Korus and Burbach 2009

Decline in Water Table 2000

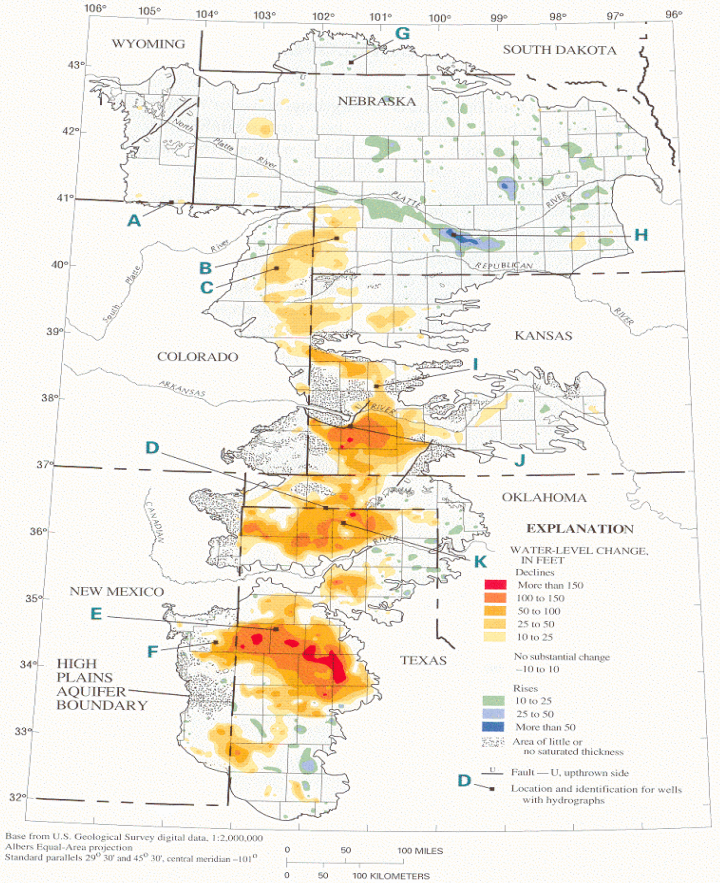
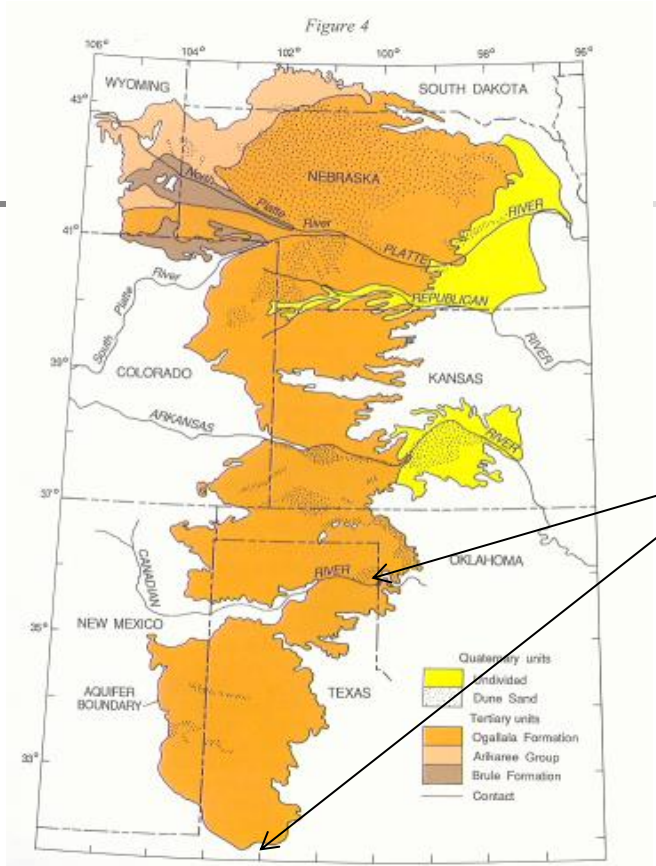


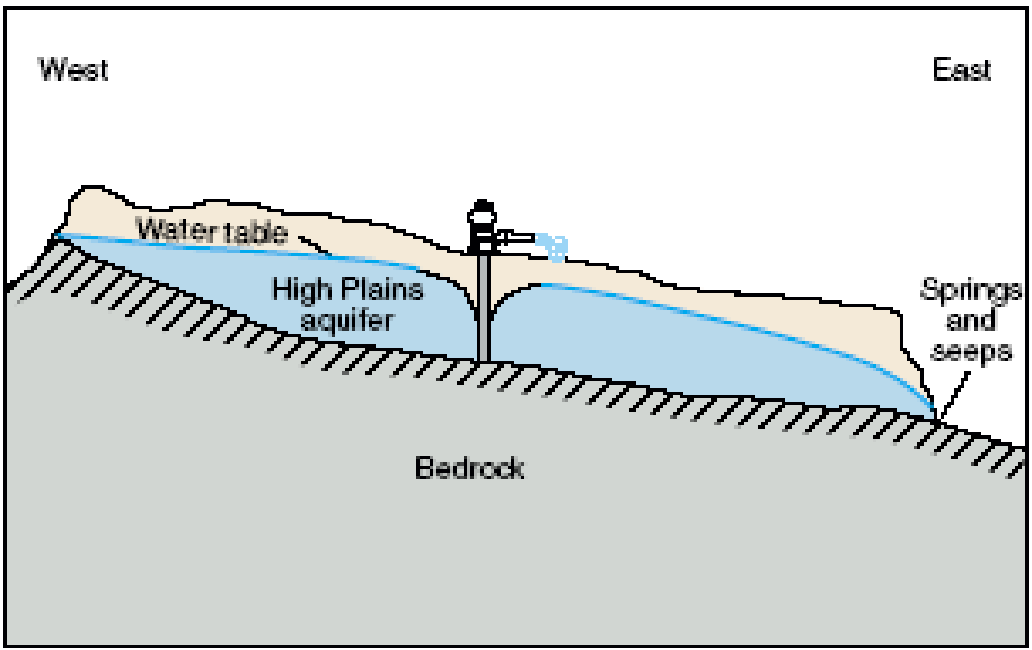
Figure 19. *Water-level changes in the High Plains aquifer, predevelopment to 2000, and location of selected wells with hydrographs. See hydrographs in figure 20.*

USGS



Area Modeled

Modified USGS

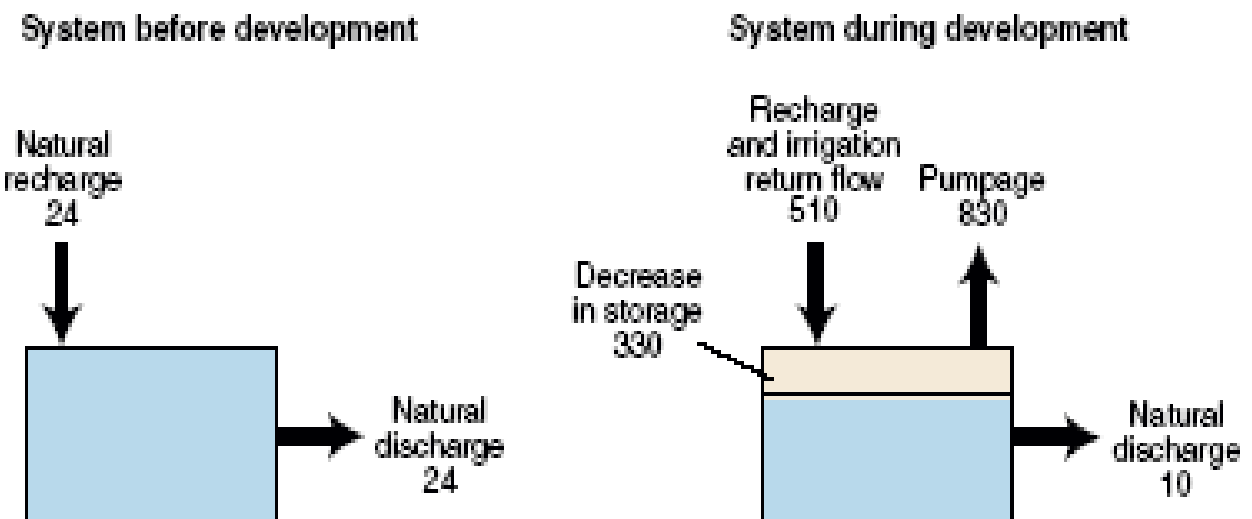


Vertical scale greatly exaggerated

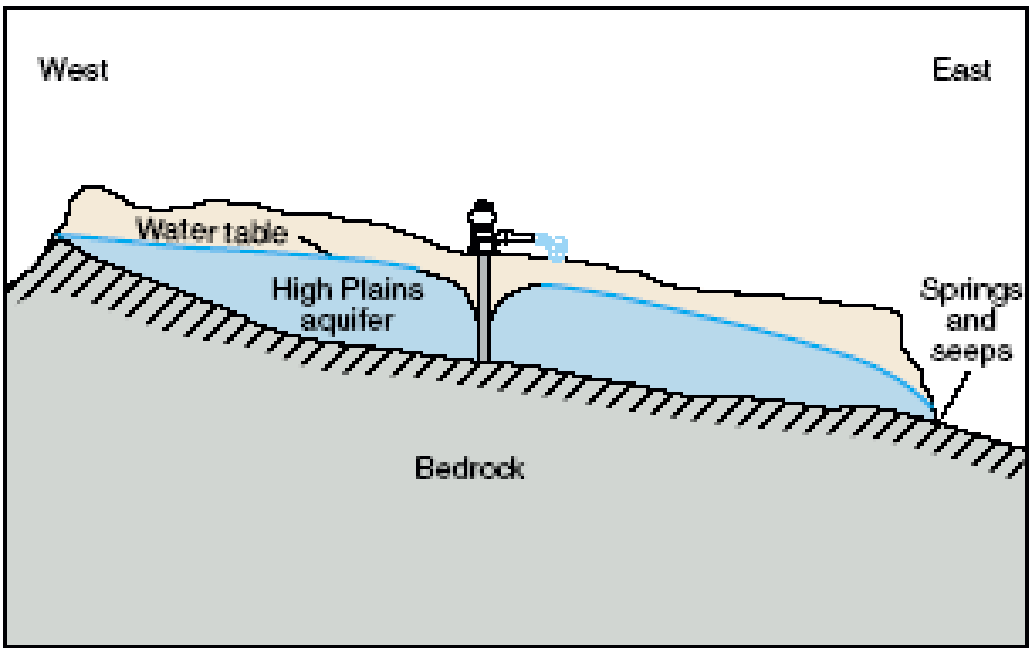
USGS

West Texas Water Budgets

B



USGS



Vertical scale greatly exaggerated

USGS

The concept of water balance is analogous to a CHECKING ACCOUNT

Base income
$200

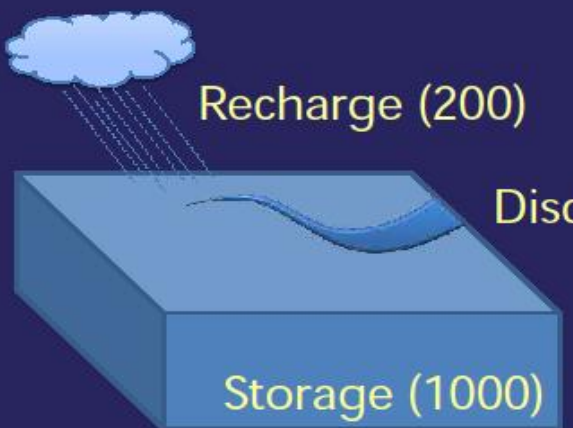
Income = Expenses

Base expenses
$200

Cash Reserve
$1,000

Let us now consider
WATER BALANCE

Recharge is like Income
Discharge is like Expenses
Storage is like Cash Reserve



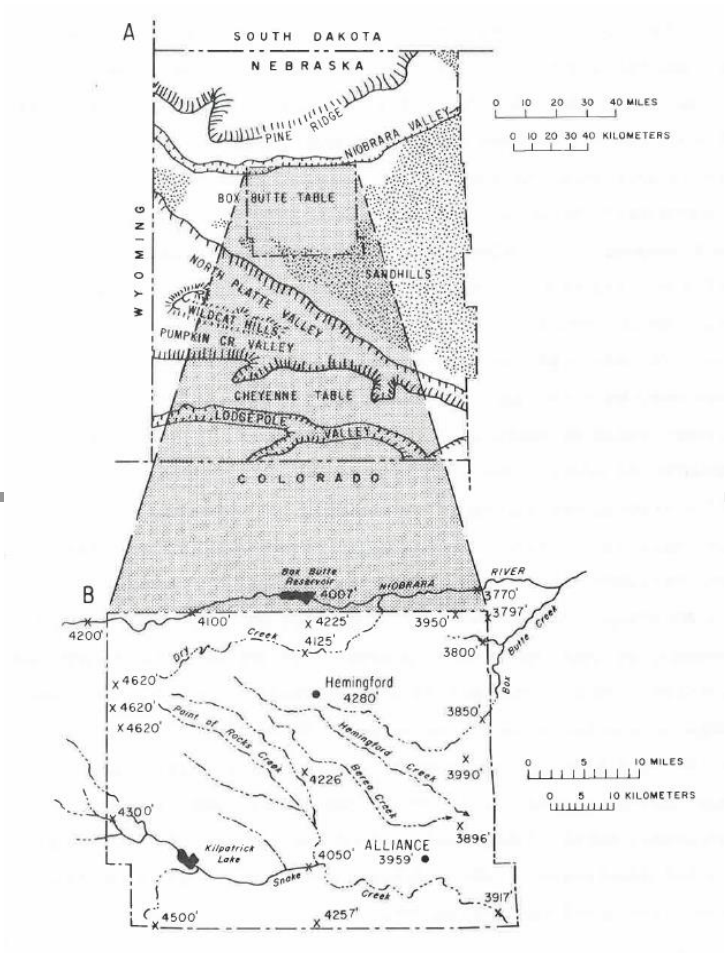
$$R = D$$

"Water Balance" vs. Checking Account

- Can Observe Change in Storage - ΔS
- Change in Discharge - ? - ΔD
- Change in Recharge - ? - ΔR
- *Managing your checking account without knowing your income or expenses*?
- Greater Drawdown = Greater Sustainable Pumping Rate [TNSTAAFL]
- Don't Try This With Your Checking Account

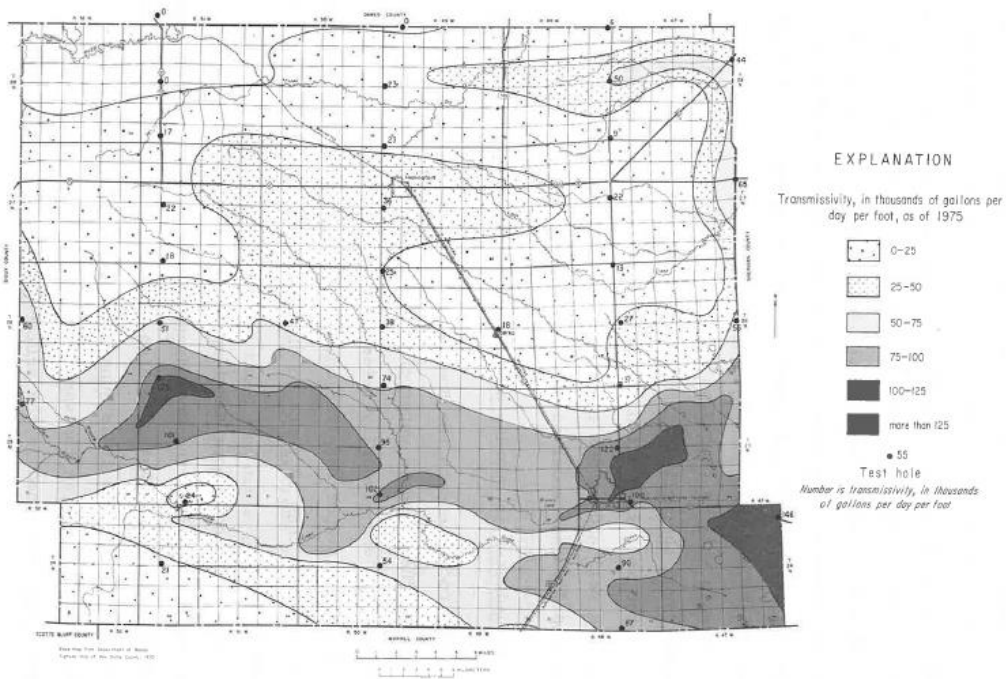
Why Study Nebraska Hydrogeology?

- Need Predictive Models
- Predict Impact of GW Pumping
- Stream Depletion
- Box Butte Water Level Declines
- GW Models Require Good Geologic Models to Avoid SWAG



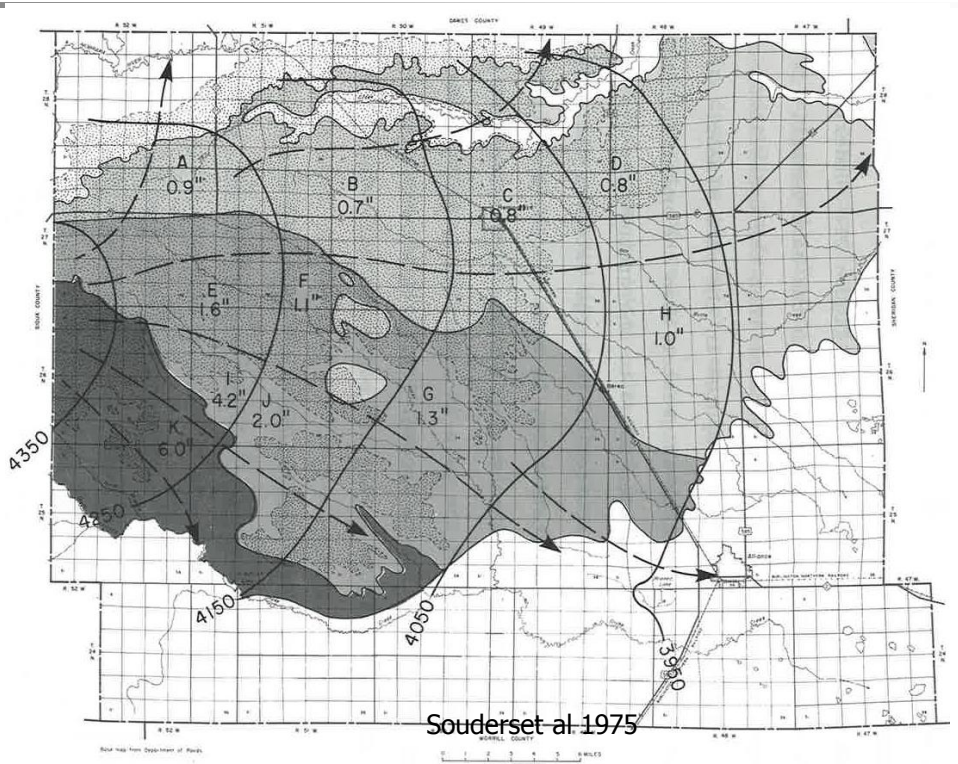
Souders et al 1975

Box Butte Co. Transmissivity

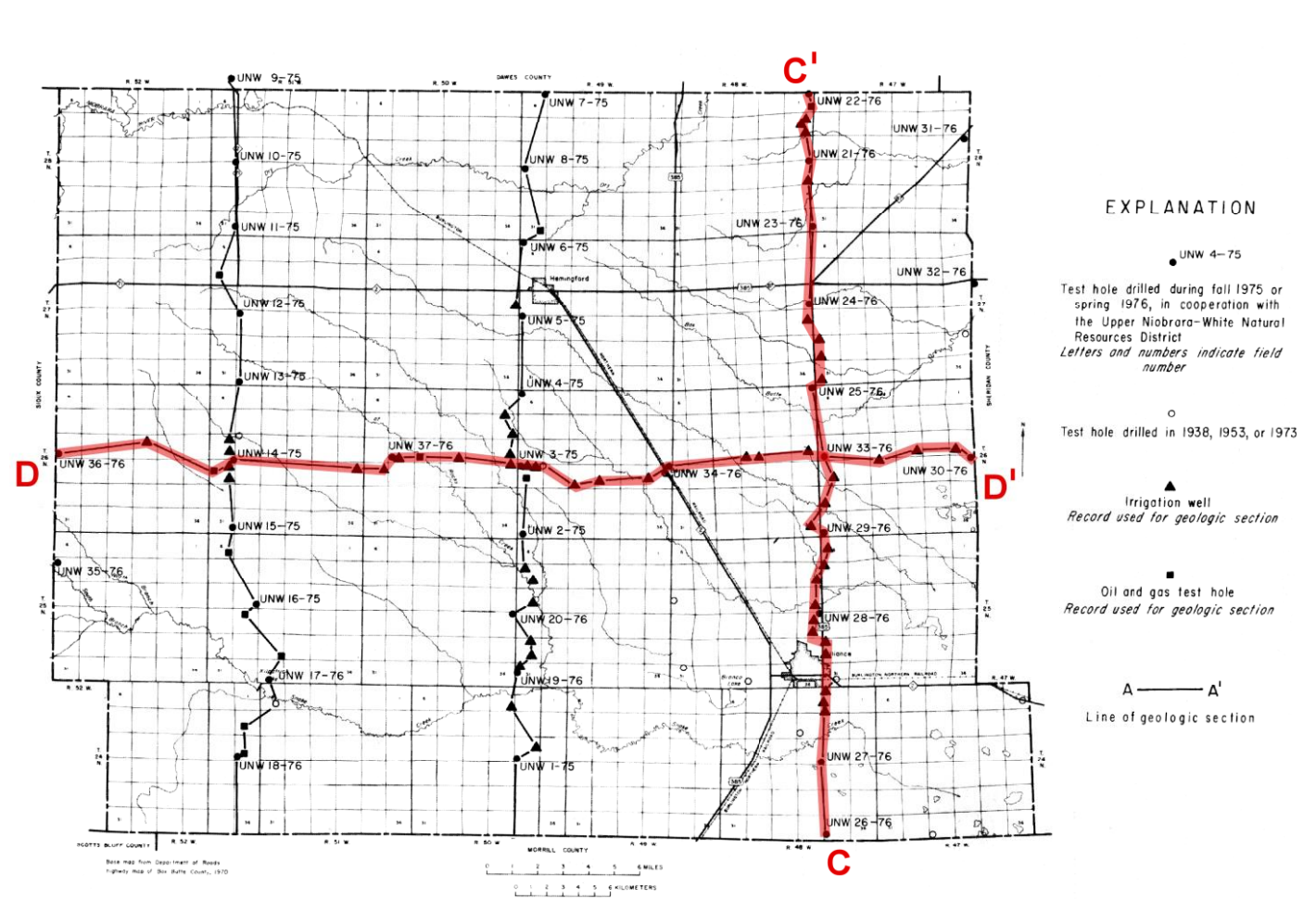


Souders et al 1975

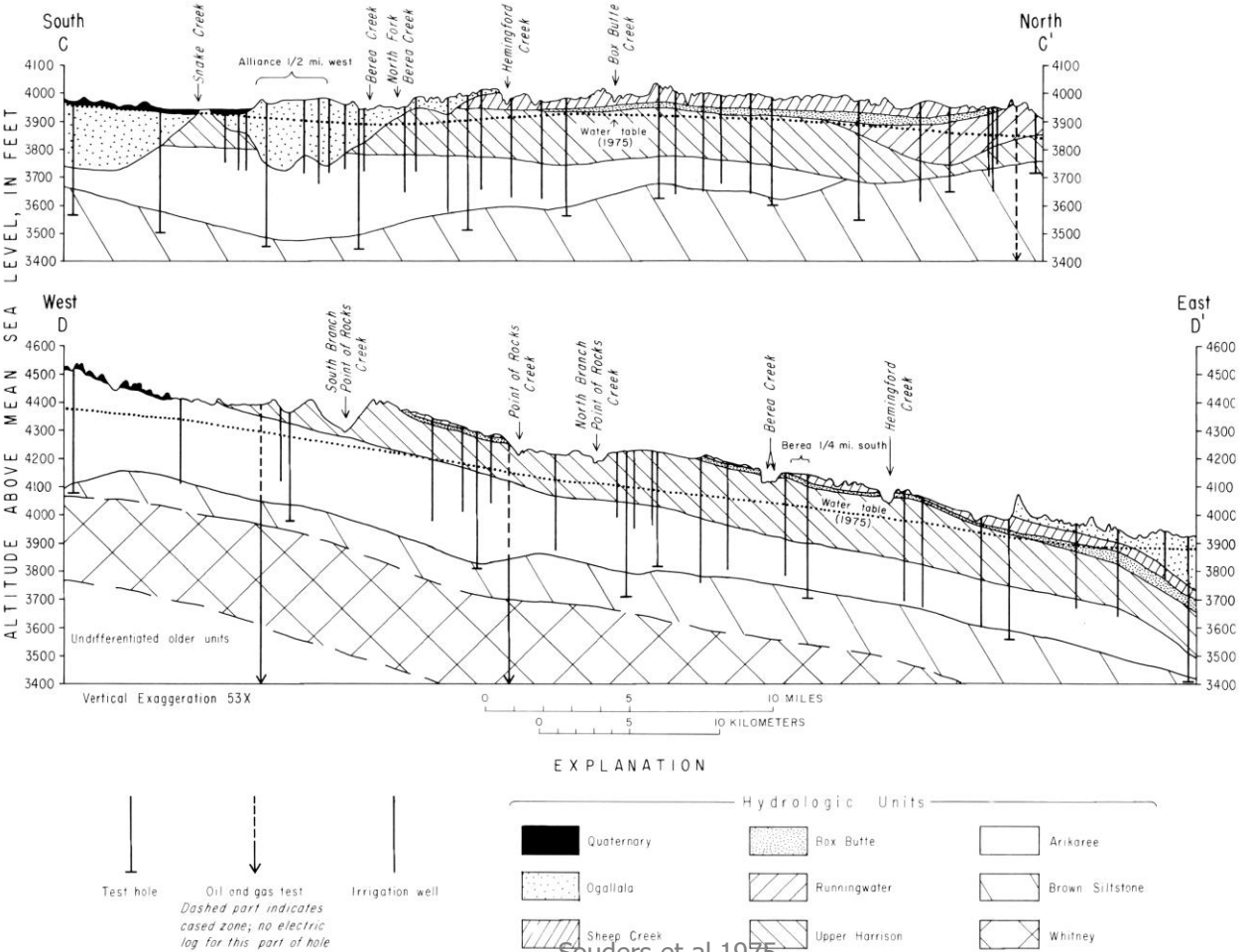
Recharge – Box Butte Co.



Souderset al 1975

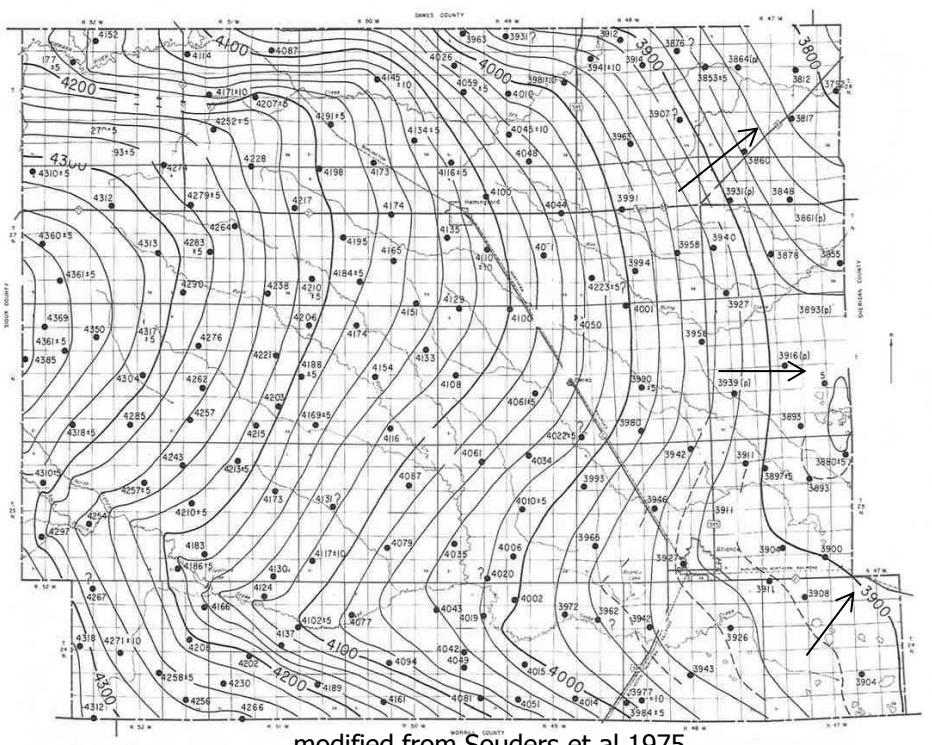


Souders et al 1975



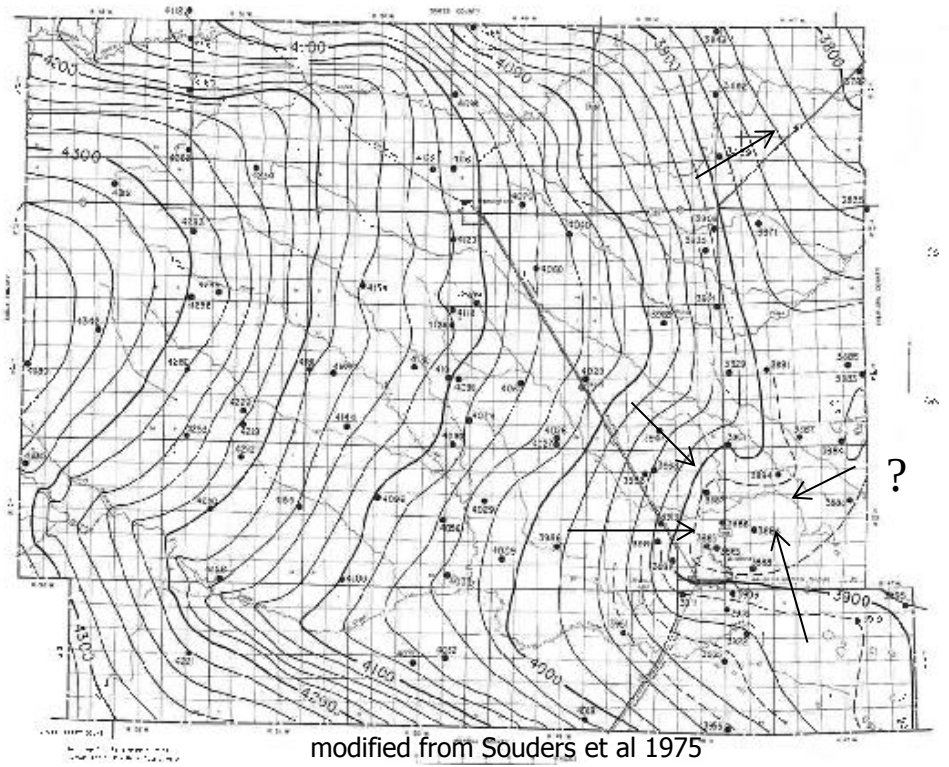
Souders et al 1975

Box Butte Co. 1938 GW Level



modified from Souders et al 1975

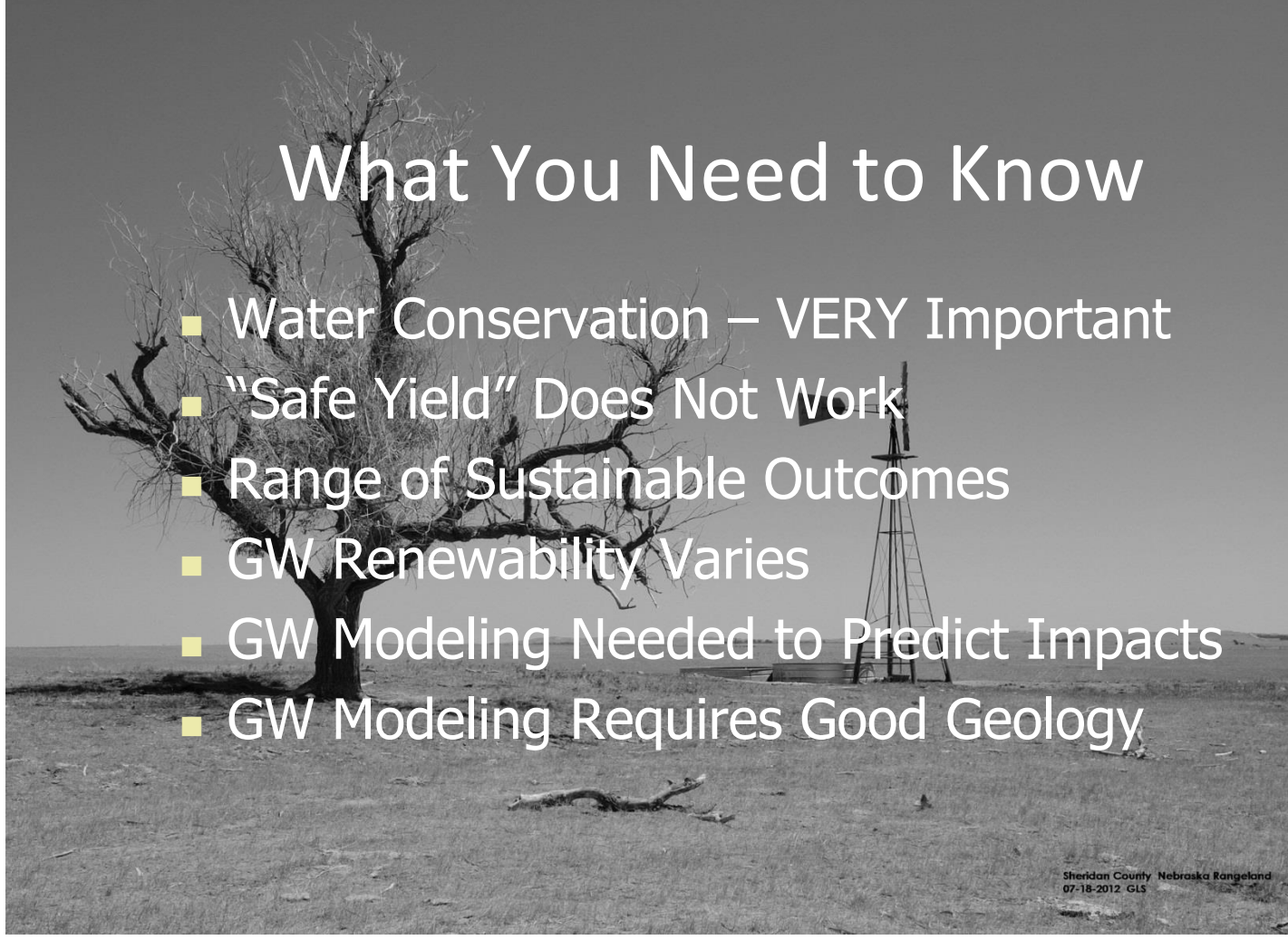
Box Butte Co. 1975 GW Level



modified from Souders et al 1975

What You Need to Know

- Water Conservation – VERY Important
- "Safe Yield" Does Not Work
- Range of Sustainable Outcomes
- GW Renewability Varies
- GW Modeling Needed to Predict Impacts
- GW Modeling Requires Good Geology



Questions?

Thank You!

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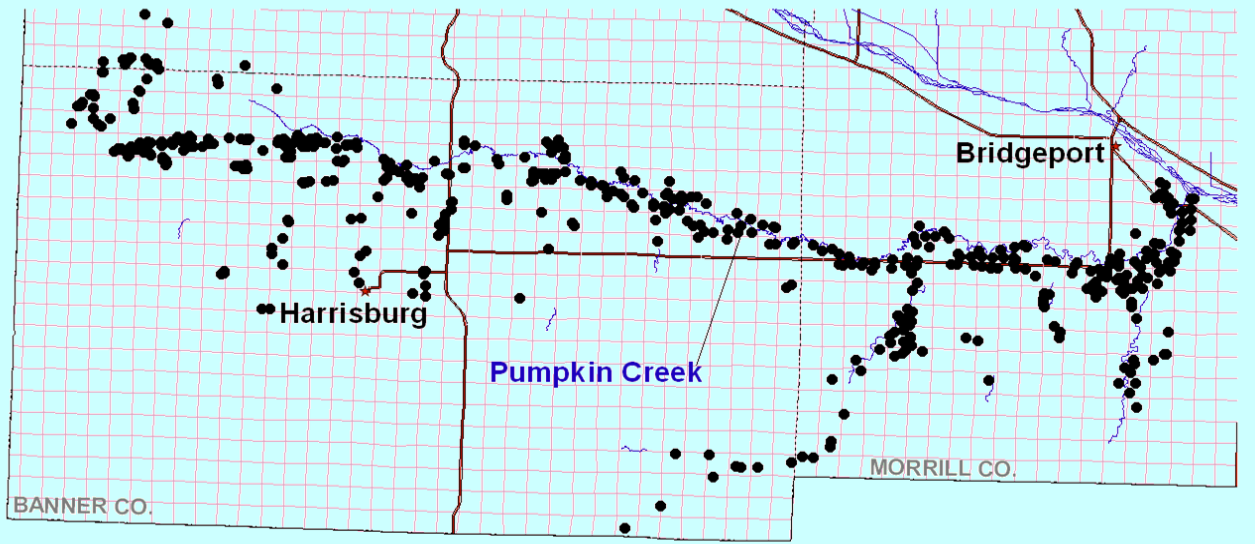
Thank You!

Registered Irrigation Wells, 1999



NORTH PLATTE
Natural Resources District